Received: 10 August 2023 | Revised: 29 January 2024 | Accepted: 5 March 2024

DOI: 10.1002/mde.4188

RESEARCH ARTICLE

WILEY

Demand-driving innovation, advertising nuisance, and a media platform optimal pricing

Chokri Aloui[1,2] | **Khaïreddine Jebsi**[1,2]

[1]Faculty of Economics and Management, University of Sousse, Sousse, Tunisia

[2]LAMIDED, Higher Institute of Management, University of Sousse, Sousse, Tunisia

Correspondence
Chokri Aloui, Faculty of Economics and Management, University of Sousse, Tunisia, LAMIDED, Higher Institute of Management, University of Sousse, Sousse, Tunisia.
Email: alouichokry2004@yahoo.fr

Abstract

This paper explores the incentives of a monopolistic media platform to invest in demand-driving innovation when the interactions between its customer groups (eyeballs and advertisers) are countervailing. We investigate whether media innovation contributes to resolving the *trade-off* between catering to both groups (or sides) and minimizing advertising nuisance. We identify an innovation threshold guiding the media platform on when to charge more eyeballs than advertisers, effectively reversing the standard *divide-and-conquer* pricing strategy. Moreover, we show that the media platform invests more in research and development (R&D) on the side with the strongest reference market, and we highlight the role of *excessive inertia* and *momentum* in shaping innovation. Furthermore, we find that when the relative advertising nuisance is low, the platform is less encouraged to innovate on both sides when the ad nuisance increases marginally. However, when the relative advertising nuisance is high, we infer an R&D *see-saw* rule: a marginal increase in the ad nuisance reduces the R&D efforts undertaken on one side and increases those on the other. Our findings provide insights into the complex interplay between media platform innovation and pricing strategy in the presence of advertising nuisance and a challenging *chicken-and-egg* problem.

JEL CLASSIFICATION
D42, L12, O32

1 | INTRODUCTION[1]

Media platforms are intricately woven networks, connecting two pivotal customer groups (or sides)—advertisers and eyeballs[2]—to achieve optimal financial, economic, and social performance. This connection, however, introduces a complex interplay marked by *countervailing* dynamics; while advertisers seek increased engagement from eyeballs, the latter *often* perceive ads as a source of nuisance.[3] Both eyeballs and advertisers engage with a shared media good, each approaching it in distinct ways. The fundamental disparity lies in the fact that eyeballs are drawn to consume the content embedded in that good. Advertisers, on the other hand, consume the messages they intend to convey through ads specifically targeted at these eyeballs. The countervailing transactions that the media platform navigates while offering a media good present a potential challenge. This introduces complexity to the classic *chicken-and-egg* dilemma that any two-sided platform faces in the quest to align both sides to consume both *media offerings*: content for eyeballs and advertising service for advertisers.

Empirical studies conducted by Wilbur (2008), Zhang (2016), and Ivaldi and Zhang (2017) highlight a negative impact in the externality from advertisers to eyeballs. Recognizing the significant magnitude of this externality, numerous digital media platforms have proactively implemented measures, including the introduction of ad-blocking techniques.[4] This proactive approach acknowledges the intrusive nature of ads, which not only consumes the time of eyeballs but also raises privacy concerns. Moreover, the majority of media platforms today persist in ongoing innovation to effectively address the issue of *conflicting* interactions between eyeballs and advertisers. The widespread adoption of digitization and digitalization in business models empowers these platforms to elevate the quality of their offerings, enticing eyeballs not only to subscribe but also to opt for ad-free experiences. Notably, media platforms such as Netflix provide ad-free plans at varying costs,[5] and YouTube offers a premium version, Youtube Red,[6] ensuring users a seamless, ad-free viewing experience. The transition to digital distribution also proves to be a lucrative venture for media outlets. For instance, The New York Times generates a substantial portion of its revenue from digital subscriptions,[7] underscoring the financial viability of this evolving landscape.

Amid this backdrop, our paper delves into the aforementioned arguments, centering on the investigation of a monopolistic media platform's incentives for R&D investment to stimulate demand and willingness to pay in the presence of countervailing interactions. Our objective is to discern the conditions under which the platform prioritizes R&D efforts on one side over the other and how the resultant innovation influences the platform's pricing policies. Operating as intermediaries in a landscape featured by indirect network externalities, where the welfare of one side depends on the expected[8] network size of the other, media platforms face a delicate trade-off between attracting eyeballs to entice advertisers while mitigating the nuisance of advertising for the former (Anderson & Gabszewicz, 2006).[9] Specifically, we explore whether an innovation strategy can reconcile such a trade-off by prompting the platform to reassess its pricing policy, addressing the inherent chicken-and-egg dilemma. Considering the role of advertising nuisance, we analyze the comparative statics of its marginal evolution on the primary equilibrium pricing and R&D variables.

To tackle this issue, we propose a two-stage optimization program for the media monopoly. The first stage determines the optimal sides' R&D efforts, while the second establishes the optimal pricing strategy on each side, considering the R&D efforts. The media monopoly handles content production and ad design internally.[10] Each consumer pays to *access* one unit of the *media offering* through the platform. For eyeballs, this is access to content (articles, videos, podcasts), while advertisers benefit from exposing ads to eyeballs. Both sides have *responsive expectations*, with consumers on each side aware of the other side's price. Though this is more evident for advertisers, eyeballs can indirectly learn about advertising prices through published articles, financial results, and promotional materials. In our paper, we keep the potential trade between eyeballs and advertisers exogenous.

We model innovation as the outcome of R&D efforts aimed at enhancing one side's market potential. Specifically, R&D efforts are assumed to deterministically boost the potential demand of one side (considered demand-driving innovation) and/or increase its willingness to pay. This not only leads to additional consumption but also encourages consumers to pay a premium. In our paper, we posit that the R&D efforts on the eyeballs' (advertisers') side deterministically yield an innovation output that enhances the quality of the content (ads) being offered. It is worth noting that the quality of the media good is contingent upon various factors. For the eyeballs, it hinges on the quality of the content they consume, the skill and wit of the hosts and journalists who animate and produce the content, the celebrity status of guests enhancing content attractiveness, and the overall quality of the entertainment provided. Additionally, it is influenced by the quantity and frequency of advertisements, as well as how these advertisements are presented to them. For advertisers, the quality of the media good is determined not only by the effectiveness of conveying their brand promotions to the eyeballs but also by the media good's capability to attract a progressively larger audience. Given the intricacy of this subject, our paper narrows its focus to explore two distinct dimensions of the overall quality of the media good: the quality of the content as perceived by eyeballs and the quality of the advertising messages as perceived by advertisers.

In recent years, media convergence[11] has significantly altered the landscape of information and entertainment production and consumption, propelled by the rapid advancement of digital technology. Notably, many newspapers, prominent TV channels, and radio stations now leverage users' historical behavioral data and employ sophisticated algorithms to offer personalized digital experiences tailored to individual habits and preferences. This personalization extends to various aspects, including personalized ads, show recommendations, and movie suggestions. As a result, media platforms are vigorously pursuing more innovative advertising approaches, focusing on generating ideas that deeply resonate with audiences to capture their attention. The goal is to stand out in an increasingly crowded digital space and create content that genuinely engages and connects with target audiences.

Our paper unveils compelling findings that carry significant implications for scholars and policymakers in media markets. In the realm of the pricing equilibrium, we have established optimal pricing rules, taking into account factors such as market power, marginal cost, and an externality-internalizing factor. These pricing behaviors are crucial for media platforms dealing with the intricate dynamics of the *chicken-and-egg problem*. They include adopting a freeness pricing strategy under specific conditions or placing the highest burden of the price level on eyeballs—a major source of attractiveness for the media platform. In our exploration of R&D efforts, we define optimal rules to achieve a balanced equilibrium. The platform strategically invests significantly in the side with the strongest pre-innovation market potential, recognizing the inherent value of the media good that consumers use to shape their network expectations. This understanding enables the media platform to adeptly address the *chicken-and-egg* dilemma, steering clear of excessive inertia. Our analysis further delves into the impact of advertising nuisance on R&D efforts, revealing nuanced incentives and strategies employed by media platforms.

The paper is organized as follows: Section 2 reviews the relevant literature. Section 3 introduces the model, while Section 4 elaborates on the characterization of the pricing equilibrium. The exploration of the R&D equilibrium is conducted in Section 5, followed by a discussion of policy implications in Section 6. Finally, Section 7 presents the concluding remarks.

2 | RELATED LITERATURE

Our paper stands as a *pioneering* effort, marking the *first* exploration of demand-driving innovation in a two-sided media market, specifically when countervailing interactions occur between eyeballs and advertisers. Beyond this critical gap bridging, we contribute significantly by delving into the pivotal role of media innovation, striving to strike a balance between attracting eyeballs and advertisers while minimizing ad nuisance for the former.

In navigating the *chicken-and-egg* challenge, the literature on two-sided markets has flourished, advocating for the widely recognized divide-and-conquer pricing strategy (D&C pricing), as proposed by Caillaud and Jullien (2003).[12] This strategy involves charging the side contributing the highest network value the lowest price, sometimes even subsidizing it.[13] While traditional media platforms historically embraced this strategy, subsidizing eyeballs for content access while advertisers bore the predominant price burden for ad placement, the digital revolution has reshaped this landscape. Despite the extensive literature on the microeconomic behavior of media companies, including contributions from Anderson and Coate (2005), Anderson and Gabszewicz (2006), Gabszewicz et al. (2001), and Sonnac (2000), among others,[14] game-theoretic works linking indirect network externalities and innovation in media two-sided markets remain limited.[15]

Recently, a few papers have explored the relationship between network externalities and platform investment strategies, utilizing diverse approaches for a comprehensive understanding. Some studies have focused on analyzing the impact of platform investments on a single side of the market, while others have ventured into examining implications when a platform invests simultaneously on both sides.

2.1 | Platform's investment reaches only one side

Dou et al. (2016) investigate optimal pricing and investment in value-added services (VAS) on competing two-sided platforms, emphasizing the impact of bilaterally positive indirect network externalities on one-sided VAS investing. Their findings indicate that, compared to no investment, the invested user side is consistently charged a higher price, while the price for the un-invested user side may increase or decrease, contingent on the magnitude of the network externalities. Dou et al. (2018) account for resource constraints, bilateral positive indirect network externalities, and negative intra-group network externalities to delve into a platform's VAS investment strategies within the sellers' market. Their study demonstrates that intra-group network externalities do not unilaterally determine the VAS investment strategy; their overall negative impact can be offset under certain conditions. The optimal VAS investment level diminishes with negative intra-group network externalities. Wei et al. (2023) examine the impacts of bilaterally positive indirect network externalities and risk aversion on Corporate Social Responsibility (CSR) investment, exclusively undertaken on the user side. They uncover that stronger network externalities do not necessarily prompt the platform to invest in CSR. Notably, when the strength of user network externality is high, CSR investment may yield a "*dilution effect*," diminishing the platform's user base and profit. Conversely, risk aversion consistently triggers an "*incentive effect*" on CSR investment, heightening the platform's inclination to invest in CSR. Additionally, both provider and user network externalities contribute to an increase in the platform's prices.

2.2 | Platform's investment reaches both sides

Li et al. (2021) address a pivotal question confronting a two-sided platform: how to strategically make investment decisions across two sides, multiple categories of goods, and different periods to ensure rapid and sustainable growth. They develop a two-category two-period theoretical model and propose optimal resource allocation strategies. The authors underscore that the platforms utilizing a membership-based charging structure should adhere to a "*reinforcing*" rule for both within- and cross-category allocations, directing more resources toward the stronger growth driver. On the other hand, platforms employing a transaction-based charging model should apply the reinforcing rule for within-category allocation but follow a "*compensatory*" rule for cross-category and intertemporal allocations, directing more resources toward the weaker growth driver. Sui et al. (2023) scrutinize bilateral decisions surrounding VAS and pricing within two cost-asymmetric à-la-Hotelling competing platforms, introducing the concept of multi-homing. Their study unveils that, in contrast to the platform with high marginal investing costs, the lower-cost platform provides a heightened VAS level to its customer groups, potentially imposing lower charges. Specific scenarios indicate that the low-cost platform may extend high VAS levels to manufacturers at a nominal fee while offering lower VAS levels to suppliers at a comparatively higher fee. Conversely, the high-cost platform may opt for elevated VAS levels with subsidies for manufacturers and reduced VAS levels with charges for suppliers. Additionally, the authors prove that, regardless of the platforms' marginal investing costs, suppliers consistently face higher charges post-VAS investment, whereas manufacturers may encounter reduced charges or even subsidies.[16]

As mentioned above, the fundamental and distinctive contribution of our paper is to disentangle the role of demand-driving innovation in solving the *chicken-and-egg* dilemma when countervailing network externalities matter. The only paper we are aware of to tackle this issue, but considering bilaterally positive indirect positive network externalities, is Aloui and Jebsi (2022). They particularly explore how a two-sided platform operating as a monopoly can overcome the *chicken-and-egg* problem by incorporating CSR into its business model.

3 | THE MODEL

We consider a private media monopoly[17] platform (cable TV, newspaper, satellite radio, etc.) that serves two distinct customer groups (sides or markets): eyeballs (superscripted B) and advertisers (superscripted S).[18] The interactions between both sides are *countervailing*. Advertisers positively *appreciate* advertising through the media platform which attracts a greater mass of eyeballs. However, eyeballs are *ad-averse* in the sense that they view publicity as *intrusive*. Consumers on side k, $k = B, S$, exhibit heterogeneity in their intrinsic valuation of the media platform, denoted as υ^k. It is important to note that each consumer on either side is assumed to make a single unit purchase of the media offering tailored to their side. For example, an eyeball acquires one content item, while an advertiser places just one advertisement. Following Belleflamme and Peitz (2019), the net utility of a consumer on side B is expressed as:

$$U^B = \upsilon^B - \theta^B N^S - p^B \tag{1}$$

Similarly, the net utility of a consumer on side S is provided by:

$$U^S = \upsilon^S + \theta^S N^B - p^S \tag{2}$$

To accommodate platform-valuation heterogeneity, we assume that consumers on side k are *uniformly* distributed across the interval $[0, a^k]$, where $a^k > 0$ represents the upper limit of the valuation scale for that side. The market potential, or the extent, of side k is also assumed to be equal to a^k.

When facing a price p^B and anticipating the participation of N^S advertisers, an eyeball decides to join the media platform when[19]:

$$U^B \geq 0 \Rightarrow \upsilon^B \geq p^B + \theta^B N^S \equiv \hat{\upsilon}^B \tag{3}$$

Similarly, an advertiser, who encounters a price p^S and expects N^B eyeballs to join the media platform, decides to participate when:

$$U^S \geq 0 \Rightarrow \upsilon^S \geq p^S - \theta^S N^B \equiv \hat{\upsilon}^S \tag{4}$$

Consequently, the demand for side B is calculated as:

$$q^B = \left[\Pr\left(\upsilon^B \geq \hat{\upsilon}^B\right)\right] a^B = a^B - \theta^B N^S - p^B \tag{5}$$

The demand on side S is determined as:

$$q^S = \left[\Pr\left(\upsilon^S \geq \hat{\upsilon}^S\right)\right] a^S = a^S + \theta^S N^B - p^S \tag{6}$$

The parameter a^k denotes the *post-innovation* market extent or strength of side k. Let $\mu = \left(a^B/a^S\right)$ and interpret it as the *post-innovation relative market strength* of side B. Note that a^k can also be thought of as the maximum that side k is willing to pay for media offering k (or its reservation price). Thus, μ represents the relative post-innovation reservation price of side B.

The exogenous parameter θ^k captures the marginal indirect network externality: *all else being equal, an expected additional sale of media offering S (B) adjusts down (up), by $\theta^B(\theta^S)$, the potential demand (or the maximal willingness to pay) of media offering B (S)*.[20] Upon *countervailing* interactions, we assume, for analytical simplicity, that $\theta^B \in]0, \theta^S[$ and $\theta^S \in]0,1[$. In our paper, the parameter θ^B is also interpreted as the *marginal ad nuisance cost (disutility)* or the *marginal network cost* of side B. The parameter θ^S is the *marginal network benefit* of side S.[21] Assuming that θ^S is strictly greater than θ^B reflects the fact that the monopoly platform operates in a media market environment where the magnitude of the marginal network value to advertisers dominates the marginal nuisance they impose on eyeballs.[22] We define the ratio $\delta = \left(\theta^B/\theta^S\right)$ as referring to the *relative advertising nuisance on the platform*. We emphasize that when δ is less than 1, *the relative advertising nuisance* is said to be *low*.[23] For simplifying reasons, variable membership costs on both sides are normalized to zero. The only fixed costs are those related to R&D investments (see below).

As mentioned above, each consumer in market k buys only one unit of media offering k for which he has to pay the price p^k to the platform.[24] p^B can be the subscription fee a reader would have to pay to buy (or to access the content of) a copy of a newspaper. It can also be the pay-per-view fee that a viewer must pay to access a pay-tv program.p^S can be the price per space or minute an advertiser must pay to advertise through the media platform.[25]

The media monopoly invests in R&D to improve the quality of each media offering to stimulate demand in each market. The innovation we define in this paper is *demand-driving or reservation-price-adjusting*. Indeed, the post-innovation market extent (or potential) of side k (or the maximal willingness to pay), regardless of network externalities, is given by[26]:

$$a^k\left(x^k\right) = \omega^k + \lambda^k x^k \tag{7}$$

where x^k designates the R&D efforts (expenditures) that the platform undertakes on side k. As mentioned in the introduction, the quality of the media good is contingent upon several factors for the eyeballs, encompassing content quality, the skills of hosts and journalists, the status of celebrity guests, and the overall entertainment quality. It is also shaped by the quantity and frequency of advertisements and their presentation. For advertisers, the quality of the media good is defined by the effective conveyance of product promotions and its ability to attract a larger audience. Given the intricate nature of this subject, our focus is narrowed down to two specific dimensions of media-good quality: content quality for the eyeballs and the quality of advertising messages for advertisers.

The *base* or *pre-innovation* market extent of side k is denoted by $\omega^k > 0$. This *baseline or reference market* potential of side k is adjusted upwardly by λ^k if the media platform spends an extra dollar in terms of R&D on that side. In other words, the R&D efforts, x^k, strengthen side k.[27] Following Häckner (2000), ω^k can also be seen as the base (*inherent*) quality of the k-media offering which can thus be improved by additional R&D efforts.[28] The pre-innovation relative *market strength* of side B is denoted by $\psi = \left(\omega^B/\omega^S\right)$. In this setting, we contend that a higher μ indicates a stronger eyeball market. This assertion is grounded in the observation that, all else being equal, an elevated μ can be attributed to an increased x^B (given ω^B), a higher ω^B (given x^B), or both being higher. Moreover, when keeping all other factors constant, a higher μ may stem from a lower ω^S and/or reduced x^S.

We assume that the media monopoly has two distinct agencies. One is devoted to the production and innovation of content, while the other is centered on the creation and innovation of advertisements. The resulting media offerings from these two agencies are combined into a single media good, through which the interactions between eyeballs and advertisers are effectively manifested. Following d'Aspremont and Jacquemin (1988), the cost of R&D on side k is assumed to be quadratic-convex. It is given by:

$$g^k\left(x^k\right)=\frac{\gamma^k}{2}\left(x^k\right)^2 \tag{8}$$

with $\gamma^k>0$ is a measure of the cost-efficiency of the platform's R&D project on side k. A lower γ^k signifies greater R&D cost-efficiency. For simplicity, we assume that $\lambda^k=\lambda$ and $\gamma^k=\gamma$ for $k=B,S$. Table 1 summarizes the notations used in the model.

TABLE 1 Summary of the notations.

Notation	Description
U^k	The net utility of a consumer on side k.
υ^k	The intrinsic valuation of a consumer on side k
$\hat{\upsilon}^k$	The intrinsic valuation of a consumer on side k who is indifferent between joining and not joining the media platform.
p^k	The access price the platform charges on side k
q^k	The quantity consumed of side k
N^k	The expected network size of side k
θ^B	The marginal ad nuisance disutility of side B
θ^S	The marginal network benefit of side S
$\delta=\left(\theta^B/\theta^S\right)$	The relative marginal advertising nuisance on the platform
a^k	The post-innovation market extent of side k. It also refers to the post-innovation maximal willingness to pay of side k.
$\mu=\left(a^B/a^S\right)$	The relative post-innovation market extent of side B
ω^k	The pre-innovation market extent of side k
$\psi=\left(\omega^B/\omega^S\right)$	The relative pre-innovation market extent of side B
x^k	The R&D efforts the platform undertakes on side k
$\gamma^k=\gamma\,\forall k=B,S$	The R&D efficiency or productivity parameter on side k
$\lambda^k=\lambda\,\forall k=B,S$	The R&D project success parameter on side k
Π	The media platform's profit

In this paper, we study the incentives of a media monopoly platform to invest in demand-driving R&D while allowing both sides to form *responsive expectations*. The *main* purpose is twofold:

- *Pricing equilibrium*: we study, for given R&D efforts, to what extent innovation, the outcome of R&D efforts, contributes to solving the *chicken-and-egg problem* around the predefined *trade-off*. Specifically, we explore how such innovation affects the platform's optimal pricing strategy when interactions between eyeballs and advertisers are countervailing. Additionally, we determine the critical marginal advertising nuisance thresholds that determine whether the media platform should subsidize or charge eyeballs the highest price. Our pricing study also explores the comparative statics related to marginal advertising nuisance, with an emphasis on the role of fixed R&D efforts. We assume that $\delta<1$ for the analysis of the pricing equilibrium.
- R&D equilibrium:
- For $\delta<1$, we study the extent to which the ad nuisance affects the media platform's incentives to invest in demand-driving R&D. Moreover, we determine the condition under which the platform favors, in terms of R&D efforts, one side over the other. Further, we establish the R&D Cost Recovery Condition. Finally, we elucidate the condition through the equilibrium R&D efforts under which the media monopolist solves the *chicken-and-egg* problem she faces.
- For $\delta\geq 1$, we are particularly interested in analyzing what we shall call the R&D *see-saw* rule.

The media monopolist solves then a two-stage optimization program.[29] In the first stage, it determines the optimal R&D efforts on both sides. In the second stage, it chooses the optimal prices given the R&D efforts. We solve the program backwardly.[30]

Based on the pioneering definition of responsive expectations proposed by Katz and Shapiro (1985),[31] we assume that the media platform *never commits to zero l-side participation* before k-side agents make their decision to join. This avoids that, for example, advertisers (are willing to pay to) display ads even if there are no eyeballs. Given *responsive expectations*, consumers on each side are willing to properly revise their *beliefs* regarding the network size of the other side.[32] Using (5) and (6) and assuming rational network expectations, that is, $N^k=q^k$, we obtain the following demand functions (let $p=\left(p^B,p^S\right)$ and $x=\left(x^B,x^S\right)$):

$$q^B(p,x)=\frac{a^B-\theta^Ba^S-p^B+\theta^Bp^S}{1+\theta^B\theta^S} \tag{9}$$

and

$$q^S(p,x)=\frac{a^S+\theta^Sa^B-p^S-\theta^Sp^B}{1+\theta^B\theta^S} \tag{10}$$

We can easily check the following comparative statics:

$$\frac{\partial q^k(p,x)}{\partial p^k} < 0 \text{ for } k = B,S, \frac{\partial q^B(p,x)}{\partial p^S} > 0 \text{ and } \frac{\partial q^S(p,x)}{\partial p^B} < 0.$$

The *direct* negative price effect on the demand of side k reflects the traditional law of (normal good) demand. However, the *cross* effects of prices are not trivial. They justify the *countervailing* interactions between both sides. Since an increase in the price of side S reduces the demand for that side, the potential ad nuisance to the eyeballs will be reduced, and therefore, their intention to participate will increase accordingly. However, an increase in the eyeballs' price will reduce their demand for the media platform. Accordingly, advertisers are seeing the audience they should be reaching shrink, and as a result, their incentives to place ads through the platform will weaken. In this regard, we point out that the media platform is faced with a *trade-off* between bringing the two sides closer together and reducing the advertising nuisance suffered by eyeballs. The following analysis shows that the platform can use both pricing and R&D (innovation) strategies to somewhat resolve such a *trade-off*, thereby surmounting the *chicken-and-egg* dilemma.

The media monopoly profit function is:

$$\Pi(p,x) = \sum_{k=B,S} p^k q^k(p,x) - \frac{\gamma}{2} \sum_{k=B,S} \left(x^k\right)^2 \tag{11}$$

with $q^k(p,x)$ are the demand functions defined in (9) and (10).

The following subsection investigates the pricing equilibrium for given R&D efforts.

4 | PRICING EQUILIBRIUM

4.1 | Equilibrium pricing rules and distortions

The following Proposition characterizes the post-innovation media monopoly pricing equilibrium.

Proposition 1. For given R&D efforts, the optimal prices of sides B and S can respectively be written as:

$$p^B(x) = q^B(x) - \theta^S q^S(x) \tag{12}$$

and

$$p^S(x) = q^S(x) + \theta^B q^B(x) \tag{13}$$

with:

$$q^B(x) = a^S \frac{2\mu + \theta^S - \theta^B}{\left(2 + \theta^S - \theta^B\right)\left(2 - \left(\theta^S - \theta^B\right)\right)}$$

and

$$q^S(x) = a^S \frac{2 + \left(\theta^S - \theta^B\right)\mu}{\left(2 + \theta^S - \theta^B\right)\left(2 - \left(\theta^S - \theta^B\right)\right)}$$

The resulting profit level is:

$$\Pi(x) = \left[q^B(x)\right]^2 + \left[q^S(x)\right]^2 - \left(\theta^S - \theta^B\right) q^B(x) q^S(x) - \frac{\gamma}{2}\left(x^B\right)^2 - \frac{\gamma}{2}\left(x^S\right)^2 \tag{14}$$

Proof. See Appendix A.[33] The optimal price on the k side is composed of two terms.[34] The first term $\left[q^B(x)\right]$ is the standard markup which measures the market power of the monopoly over side k. The second term embodies the fact that the monopolist internalizes the network externalities flowing between the two sides. The platform charges advertisers the nuisance cost $\left[\theta^B q^B(x)\right]$ they impose on eyeballs. These latter see their price reduced by the network benefits $\left[\theta^S q^S(x)\right]$ they provide to advertisers. ■

According to Tan and Wright (2021), when there is heterogeneity in membership benefits and costs, optimal pricing comparisons between a two-sided private monopoly and a two-sided social planner result in *market power and scale distortions*. However, the authors have not explained the underlying causes of these distortions. In our analysis, we contend that the under-provision of the private monopoly product in one market could be a factor contributing to both power distortion in that market and scale distortion in the other market. We further support this argument by demonstrating in Section 4 that the under-provision of this product in one market is a result of under-investment in R&D efforts in that market.

Thus, the pricing rules (12) and (13) can be restated as (see Appendix A):

$$p^B(x) = \underbrace{-\theta^S q_W^S(x)}_{\substack{\text{Socially optimal price} \\ \text{on side } B}} + \underbrace{q^B(x)}_{\substack{\text{Markup over} \\ \text{side } B}} + \underbrace{\theta^S\left(q_W^S(x) - q^S(x)\right)}_{\text{Scale distorsion on side } B} \tag{15}$$

and

$$p^S(x) = \underbrace{\theta^B q_W^B(x)}_{\substack{\text{Socially optimal price} \\ \text{on side } S}} + \underbrace{q^S(x)}_{\substack{\text{Markup over} \\ \text{side } S}} + \left(\underbrace{-\theta^B\left(q_W^B(x) - q^B(x)\right)}_{\text{Scale distorsion on side } S}\right) \tag{16}$$

where $q_W^B(x) > q^B(x)$ and $q_W^S(x) > q^S(x)$ denote the socially optimal demands on sides B and S, respectively. These demands are expressed by:

$$q_W^B(x) = a^S \frac{\mu + \theta^S - \theta^B}{(1+\theta^S - \theta^B)(1-(\theta^S-\theta^B))}$$

and

$$q_W^S(x) = a^S \frac{1 + (\theta^S - \theta^B)\mu}{(1+\theta^S - \theta^B)(1-(\theta^S-\theta^B))}$$

It can be easily checked that the media monopoly *under-provides* both media offerings. The pricing rules (15) and (16) show the *two sources of distortions* implied by the *private* monopoly position of the media platform. The first source $[q^k(x)]$ is the traditional *market-power distortion* over side *k*. The second one $[\pm\theta^l(q_W^l(x) - q^l(x))]$ is the *scale distortion* which means that the network benefits (costs) to side *S* (on side *B*) caused by additional participation on side *B* (side *S*), under a private monopoly, *diverge from* that under a monopoly social planner maximizing social surplus. In this regard, we notice that, upon (15) [(16)], the scale distortion is positive (negative) on side *B* (*S*), thus scaling up (down) the markup. In other words, the media platform has an *under-incentive* to *reward* (*penalize*) the *B*-side (*S*-side) for contributing to (causing) the network benefit (network cost) of the *S*-side (*B*-side) through the platform. It should be emphasized that scale distortion does not hold in the market where consumers have *passive* rather than *responsive* expectations. Under passive expectations, the monopolistic platform is unable to internalize the network externalities generated by this market toward the opposite market.

The identified scale distortion within the framework of a monopoly media platform unveils crucial insights for proficient management and policy formulation. This revelation highlights the necessity for regulatory intervention to effectively internalize the network externalities inherent in the private monopoly platform. The regulatory objective should be to guide the private monopoly equilibrium toward the socially optimal state. This can be achieved, for instance, by *implementing a taxation/subsidy policy* on one or both sides. Such a *regulatory framework* can be seamlessly integrated (or embedded) into the private monopoly's pricing policy through the adoption of newly formulated and standardized media *guidelines*. This regulation should exercise caution and avoid inadvertently undermining the attractiveness of the private media platform.

4.2 | Impact of the marginal ad nuisance cost on the equilibrium prices: counterintuitive results

Typically, eyeballs may be reluctant to pay higher prices for media content as long as they are bombarded with advertisements. So, to reduce this negative effect, one would expect the platform's logical reaction to increasing θ^B to be to decrease $p^B(x)$ and increase $p^S(x)$. We show in Proposition 2 that this is not always necessarily the case; the scale of innovation plays a crucial role.[35]

Proposition 2. We show the following results[36]:

Result i $\frac{\partial p^B(x)}{\partial \theta^B} \geq 0$ under Ω_1

Result ii $\frac{\partial p^S(x)}{\partial \theta^B} \leq 0$ under Ω_3 with conditions Ω_1 and Ω_3 are defined in Appendix A.

Proof. See Appendix A. provide some context for Results (i) and (ii), the following intuitions can be considered[37]: ∎

Result (i)

We show in Appendix A that the intuition underlying Result (*i*) of Proposition 2 is that an increase in the marginal network cost (θ^B) reduces the platform's profit margin $(m^B(x) = q^B(x))$ less than it reduces the price discount $\left(d^B(x) = \theta^S q^S(x)\right)$. In other words, when the ad nuisance (at the margin) is increased, the monopolist, under Ω_1, is said to behave *opportunistically*: it rewards eyeballs less for the network benefits they bring to advertisers than it tolerates a drop in its profit margin on side *B*. It does this because it is aware that, under Ω_1, market *B* is stronger than market *S* $(\mu \in]1, +\infty[)$. We argue here that the scale of media product innovation could play a key role. The wider market potential could reflect intense R&D efforts allowing the platform to adjust the price of side *B* upwards despite the increase in advertising nuisance. The smaller decline in the monopoly's profit margin in the eyeball market may be explained by the fact that the highest content *quality*, especially for $\omega^B = \omega^S$, not only gives it significant market power but also allows eyeballs to *stomach* the increasing nuisance of advertising.

Reasoning by absurdity, another economic intuition can be given to Result (*i*) of Proposition 2. Under condition Ω_1, the reduction in $p^B(x)$ as θ^B increases may induce additional *B*-side participation. As a result, *S*-side participation will go up, implying an intensification of advertising nuisance. Therefore, other participating eyeballs will leave the platform. Aware of this *shadow within-side negative externalities* under Ω_1, the media platform is more inclined to scale up $p^B(x)$ when θ^B increases.

Conducting numerical simulations, we illustrate Result (*i*) in Figure S1 (see Appendix A).

Result (ii)

The intuition behind Result (ii) with non-increasing total nuisance cost in θ^B.

In the case where the total nuisance cost $(n^S(x) = \theta^B q^B(x))$ is non-increasing in θ^B, we show in Appendix A that the unexpected decrease in $p^S(x)$ resulting from an increase in θ^B is due to the negative impact of θ^B not only on the platform's markup on side *S* $(m^S(x) = q^S(x))$ but also on the total nuisance cost that side *S* imposes on side *B* $(n^S(x))$. Specifically, as advertising nuisance increases marginally, the platform's market power over advertisers weakens, and its ability to internalize the full cost of the nuisance through *S*-side pricing diminishes. This is because the media monopoly has less incentive to internalize the cost of the ad nuisance for eyeballs as its audience size decreases with the rising θ^B, that is, $\frac{\partial q^B(x)}{\partial \theta^B} < 0$.

The intuition behind Result (ii) with increasing total nuisance cost in θ^B.

In the case where the total nuisance cost is increasing in θ^B, we show in Appendix A that, although a positive change in θ^B increases the monopolist's ability to internalize the total nuisance cost $\left(\frac{\partial n^S(x)}{\partial \theta^B} > 0\right)$, it strongly reduces its market power over the S side $\left(\frac{\partial m^S(x)}{\partial \theta^B} < 0\right)$. The latter effect (*in absolute value*) dominates the former effect giving rise to a decrease in $p^S(x)$ when θ^B increases.

Under Ω_3, the media offering's quality that the platform offers to eyeballs remains *relatively* limited as $\mu \in]0,1[$. In the presence of increased ad nuisance, this poor quality will be amplified. Indeed, the eyeball side's demand will be so low that it will not be as attractive to advertisers. The latter, even benefiting from a relatively higher quality, would be less encouraged to join the platform. To compensate for this fact, the platform would be more inclined to adjust $p^S(x)$ downwards when θ^B increases.

We can provide another intuitive connection between Result (ii) and the *clutter* or *rivalry* effect that side S may encounter. When Ω_3 is in effect, side B's market potential is relatively weaker ($\mu \in]0,1[$), making it more vulnerable to a further weakening from an increase in θ^B. Consequently, the advertising reach becomes inadequate, leading to fierce competition between advertisers for reaching the eyeballs. This, in turn, results in the advertisers overcrowding each other. To mitigate this effect, the platform reduces $p^S(x)$ as θ^B increases.

Using numerical simulations, we illustrate Result (*ii*) in Figure S2 (see Appendix A).

Result (*i*) (resp. (*ii*)) indicates that the platform can increase (resp. decrease) $p^B(x)$ (resp.$p^S(x)$) even if θ^B increases only when side B (resp. side S) is potentially stronger than side S (resp. B). We argue here that the resulting demand-driving innovation can play a crucial role in guiding the pricing behavior of the media monopoly.

4.3 | Analysis of the D&C pricing strategy

The examination, in Proposition 2, of counterintuitive price shifts concerning marginal ad nuisance leads to the conclusion that the platform can embrace a pricing strategy deviating from the standard D&C approach, relying on innovation scales on both sides. This strategy has the potential for reversal, allowing the platform to charge eyeballs the highest access price, notwithstanding the advertising nuisance they endure. The subsequent Proposition not only scrutinizes this deduction but also implicitly and explicitly explores the freeness pricing strategy on side B, contingent upon the magnitude of countervailing network externalities.

Proposition 3.

- **Result (i): Implicit freeness condition**

Optimality dictates that the media monopoly charges eyeballs a zero price (at marginal cost),[38] that is, $p_f^B = 0$ when[39]

$$\theta^S q^S(x) = q^B(x) \tag{17}$$

Under (17), side S is subject to a price given by:

$$p_f^S(x) = (1 + \theta^B\theta^S) q^S(x) > 0$$

- **Result (ii): Explicit eyeball's side subsidizing condition**

The media platform optimally subsidizes eyeballs, given that:

$$p^B(x) \leq 0 \text{ and } p^S(x) > 0 \text{ under } \Omega_5$$

- **Result (iii): Explicit reversed D&C pricing strategy**

The eyeball market is charged a higher price compared to the advertiser market. We have[40]:

$$p^k(x) > 0 \text{ and } p^B(x) \geq p^S(x) \text{ under } \Omega_6$$

Conditions Ω_5 and Ω_6 are detailed in Appendix A.

Proof. See Appendix A. ■

In the following, we outline some explanations of Results (i)–(iii) presented in Proposition 3.

Result (i)

When the network benefits that advertisers derive from eyeballs, $\theta^S q^S(x)$, reach a critical level ($q^B(x)$), profit maximization prompts the media monopolist to offer free access to eyeballs (at marginal cost). This strategy is coupled with charging advertisers a positive price denoted as $p_f^S(x)$. The logic behind free access to eyeballs is the higher demand it attracts on their side, broadening advertiser participation and offsetting profits for the media monopoly. This is evident in the pricing strategy adopted by some ad-supported media platforms, such as Metro in the UK and 20 Minutes in France, which distribute free newspapers to the public. In this implicit reasoning, when advertiser network benefits surpass the critical level $\left(\theta^S q^S(x) > q^B(x)\right)$, the media monopolist charges eyeballs a price below cost, that is, $p^B(x) < 0$.[41] This pattern is observed in media outlets where radio stations and online platforms offer content for free to attract a larger audience. For example, with one free click, you can listen to *France Info* radio and watch its TV channel at the same time.

Building on Result (i), we define the ratio

$$\rho(x) = \frac{q^B(x)}{q^S(x)} \tag{18}$$

as the advertising reach of the media platform.[42] The freeness condition holds when the advertising reach equals the marginal network benefit to side S. We have (using (12), (17), and (18)):

$$p_f^B(x) = 0 \text{ if } \underbrace{\rho(x)}_{\substack{\text{The media platform's} \\ \text{advertising } reach}} = \underbrace{\theta^S}_{\substack{\text{Marginal network} \\ \text{benefit on } S}}$$

Given the circumstances $q^B(x) = \theta^S q^S < q^S(x)$, the ratio $\rho(x) < 1$ can be interpreted as a probability. This underscores that the freeness condition is met when the probability that a brand's advertisement is seen $(\rho(x))$ coincides with the probability that the seen brand is purchased (θ^S). Below-cost pricing occurs when the advertising reach is sufficiently low:

$$p^B(x) < 0 \text{ if } \rho(x) < \theta^S$$

Result (ii)

This result delves more explicitly into the freeness and below-cost pricing conditions, emphasizing the role of advertising nuisance. It reveals that the media platform can charge eyeballs a price lower than marginal cost, contingent upon advertisers paying a higher compensating price to maintain a positive price level. This lossy pricing is employed in the eyeball market when its potential is weaker than that of advertisers, that is, $\mu \in]0,1[$, indicating a lack of product innovation on the eyeball's side. The primary objective of this subsidizing pricing strategy is to expand the eyeball market by not only mitigating the price effect but also addressing the challenge of low content quality. On the other hand, given the greater strength of the S-market, advertisers exhibit a heightened willingness to pay for access to the media platform's advertising service. Capitalizing on this strong S-market might even entail providing "*gifts*" to eyeballs.

Result (ii) suggests that the media platform aims to attract more eyeballs to increase the advertiser base. However, it is crucial to acknowledge a potential undisclosed motive behind this strategy. The platform may be masking the poor quality of its content by relying on sheer eyeball numbers to generate revenue. This could explain the proliferation of ad-supported media platforms producing *fake news* and exhibiting *political bias*. During elections, media outlets not charging for access may attract more political ads, prioritizing attracting eyeballs over producing accurate and unbiased content. In the realm of politics, attracting more eyeballs often takes precedence over content accuracy and impartiality. Elder and Paul (2020) argue that "*online news sources funded by advertising depend on a business model wherein consumers are kept engaged long enough to view advertisements. Again, this engagement can be maintained by telling people what they want to hear, or producing content that entertains or outrages more than it informs.*"

We define in Appendix A the *freeness marginal ad nuisance threshold*, which reveals the freeness pricing strategy. We have:

$$p^B(x) = 0 \text{ for } \theta^B = \theta_5^B, \theta^S \in \left]\theta_3^S, \theta_5^S\right[\text{ and } \mu \in]0,1[$$

In scenarios where the market of side B is weaker ($\mu \in]0,1[$), and the marginal network benefits to advertisers are moderate ($\theta^S \in \left]\theta_3^S, \theta_5^S\right[$), there exists a threshold of the marginal ad nuisance $[\theta_5^B]$ guiding the monopolist on when to balance value through the platform by subsidizing eyeballs. We term this the *freeness ad-nuisance threshold*. It is shown in Appendix A that as θ^S (resp. μ) increases, the threshold θ_5^B decreases (resp. increases). The media platform is more (resp. less) likely to adopt the freeness pricing strategy with increasing θ^S (resp. μ).

Figure S3 in Appendix A, based on numerical simulations, illustrates Result (ii) in Proposition 2.

Result (iii)

Under condition Ω_6, the media monopoly charges ad avoiders the highest access price while offering advertisers the lowest price.[43] This results in a reversed version of the D&C pricing strategy, where the *needing-more* market (S) is subsidized instead of the *needed-more* market (B). The rationale is rooted in the recognition that the eyeball market is stronger enough to generate value (i.e.$\mu \in [1,+\infty[$), while the advertiser market is weaker and requires a lower price to boost its strength. Despite advertisers perceiving the quality of ads on the media platform as low, diminishing its overall appeal, eyeballs consider the content quality to be sufficiently high, compensating for any potential nuisance they might endure. Consequently, eyeballs attribute a high value to the media platform, justifying their willingness to pay a higher price. The media platform adjusts its pricing strategy, taking into account not only indirect network externalities but also product quality. Essentially, when confronted with considerations of both content quality and advertising nuisance on side B, the media monopolist shifts away from the D&C pricing strategy when the quality of the content overwhelmingly mitigates the nuisance.

Section 4 further demonstrates that the reversal of the D&C pricing strategy occurs when R&D efforts in market B significantly surpass those in market S. The primary reason is that higher R&D efforts in the eyeball market lead to a substantial improvement in product quality.

Traditional D&C pricing is being reversed in the media world. As Ken Doctor argues, "*We're about to move into a period in which reader revenue surpasses advertising revenue as the main support of many news (paper) companies. It's yet another kind of profound crossover demonstrating again how quickly news business models are changing. With readers paying most of the freight comes a new series of profound questions, ones that we should start asking as we try to understand this change.*"[44] The Guardian, in 2003, adopted a pricing strategy allowing readers to pay for exclusive content.[45] Pay-per-view pricing is gaining popularity among sports-centric TV channels, exemplified by industry leaders like BeinSports, Amazon TV, and Canal+. These channels cater to viewers who are willing to subscribe and pay to watch matches, providing an enticing option due to the exceptional quality of their exclusive sports broadcasts. Adweek.com, a marketing platform, offers premium quality content only to paying subscribers.[46] Larry Kilman stated that "*the basic assumption of the news business model—the subsidy that advertisers have long provided to news content—is gone. This is a seismic shift from a strong business-to-business emphasis—publishers to advertisers—to a growing business-to-consumer emphasis, publishers to audiences*."[47]

In conclusion, media companies are adapting their pricing strategies as eyeball revenue becomes increasingly important. This trend raises important questions about the future of news business models, emphasizing the need to pay attention to these changes as they unfold.

It is crucial to acknowledge that attracting a substantial number of advertisers through a relatively lower price might result in an excessive and bothersome presence of advertising for eyeballs. However, we contend that the appeal of delivering high-quality content to eyeballs can outweigh the nuisance externality. Additionally, advertisers, experiencing reduced exposure due to the lower quality of their ads, might be less motivated to join the media platform even with a discounted price. As a result, this would lead to a more manageable number of ads for eyeballs on the platform.

We define, in Appendix A, the *non-discrimination ad nuisance threshold*, indicating when a non-discriminatory pricing strategy becomes apparent:

$$p^B(x) = p^S(x) \text{ for } \theta^B = \theta_6^B, \theta^S \in \left]\theta_8^S, \theta_7^S\right[\text{ and } \mu \in \left]1, +\infty\right[$$

The media platform adopts a non-discriminatory pricing strategy when the marginal advertising cost reaches a critical nuisance threshold $\left[\theta_6^B\right]$. This threshold acts as a proxy indicating when to reverse the D&C pricing strategy. It is shown in Appendix A that:

$$\frac{\partial \theta_6^B}{\partial \theta^S} < 0 \text{ and } \frac{\partial \theta_6^B}{\partial \mu} > 0$$

An increase in the (*moderate*) marginal network benefit to the S-side decreases the threshold θ_6^B. When the marginal network benefits to advertisers are increasing, the media monopoly tends to reverse the D&C pricing strategy only with lower marginal advertising nuisance. However, an increase in μ(being in $]1, +\infty[$) incites the media monopolist to reverse the D&C pricing strategy even for a higher ad nuisance threshold.

For $\mu \in]1, +\infty[$ and under Ω_6, when the marginal network benefit to side S is relatively low, that is, $\theta^S \in \left]0, \theta_8^S\right[$, the media platform charges eyeballs the highest price, regardless of the magnitude of the marginal advertising nuisance experienced by eyeballs i.e.$\theta^B \in \left]0, \theta^S\right[$. On the other hand, when such network benefits are relatively moderate, that is, $\theta^S \in \left]\theta_8^S, \theta_7^S\right[$, imposing the highest price-level burden on side B requires a lower advertising nuisance, that is, $\theta^B \in \left]0, \theta_6^B\right[$. The D&C pricing strategy is never reversed when side B is weaker than side S.

Considering the previously defined advertising reach, we easily verify that the D&C pricing strategy is reversed when this reach is sufficiently high. We have:

$$p^k(x) > 0 \text{ and } p^B(x) \geq p^S(x) \text{ for } \rho(x) \geq \frac{1+\theta^S}{1-\theta^B} > \theta^S$$

In this setting, the non-discrimination rule holds insofar as:

$$p^B(x) = p^S(x) \text{ for } \rho(x) = \frac{1+\theta^S}{1-\theta^B} > \theta^S$$

Using numerical simulations, Figure S4 in Appendix A displays the reversed D&C pricing strategy.

The following section studies the media monopoly R&D equilibrium.

5 | R&D EQUILIBRIUM

In this section, we determine and examine the optimal R&D efforts brought out by the media monopoly on both sides.

5.1 | Analysis of the optimal R&D efforts

The following Proposition characterizes the optimal R&D efforts.

Proposition 4. The optimal R&D investment on side k is provided by[48]:

$$\underbrace{\hat{x}^k}_{\substack{\text{Equilibrium} \\ \text{R\&D investment}}} = \underbrace{\frac{\lambda}{\gamma}\hat{q}^k}_{\substack{\text{Relative returns} \\ \text{on R\&D investment}}} \tag{19}$$

with (for $k = B$)

$$\hat{q}^B = \gamma \frac{(2\gamma - \lambda^2)\psi + (\theta^S - \theta^B)\gamma}{\left((2+\theta^S-\theta^B)\gamma - \lambda^2\right)\left((2-(\theta^S-\theta^B))\gamma - \lambda^2\right)}\omega^S$$

and (for $k = S$)

$$\hat{q}^S = \gamma \frac{2\gamma - \lambda^2 + \gamma(\theta^S - \theta^B)\psi}{\left((2+\theta^S-\theta^B)\gamma - \lambda^2\right)\left((2-(\theta^S-\theta^B))\gamma - \lambda^2\right)}\omega^S$$

Equality (19) implies that the R&D Cost Recovery Condition on side k is satisfied *at the margin* in that:

$$\underbrace{\gamma\widehat{x}^k}_{\text{Marginal R\&D cost on side }k} = \underbrace{\lambda\widehat{q}^k}_{\text{Marginal return on R\&D investment on side }k}$$

Proof. See Appendix A. ∎

Equation (19) teaches that the equilibrium R&D efforts on side k, $\left[\widehat{x}^k\right]$, must be equal to the *relative* returns on these efforts, $\left[\frac{\lambda}{\gamma}\widehat{q}^k\right]$. We *shall* define the term $\frac{\lambda}{\gamma}$ as the marginal *benefit–cost ratio* of the R&D project on side k.

Parting from (19), we define in (20) the at-the-margin R&D Cost Recovery Condition on side k. In this setting, we shall interpret λ as the shadow price of one dollar invested in R&D on side k. According to the relationship (20), investing an additional dollar in R&D on market k will result in returns from equilibrium participation that cover the marginal cost of R&D. Additionally, Equation (20) demonstrates that increasing R&D efforts on side k leads to a higher level of equilibrium demand on that side. This finding justifies the media monopolist's use of R&D investment on one side as a non-pricing factor to attract members to that side.

We compare, in Corollary 1, the equilibrium R&D efforts of the private media monopolist with that of a social planner.

Corollary 1. The media monopolist *under-invests* in R&D on side k when compared to a social planner:

$$\widehat{x}_W^k > \widehat{x}^k \tag{20}$$

Proof. See Appendix A. ∎

As previously stated, Tan and Wright (2021) have discussed the main distortions that can occur when comparing how a two-sided private monopoly and a two-sided social planner determine their optimal pricing strategies. Although their work sheds light on this issue, it does not explain the root causes of these distortions. Our analysis proposes that a potential cause of these distortions is the underinvestment in R&D in market k. Specifically, our analysis suggests that the media monopoly *underinvests* in R&D to gain power in the k market. Compared to a social planner, the media monopoly is willing to forego a certain amount of R&D expenditures to induce less demand in the k market. However, the lower demand is more than offset by the effect of a higher price. Furthermore, the underprovision of R&D in market k reinforces the scale distortion in the other market, l.

Management insights suggest promoting innovation to enhance the quality of the media good, particularly in comparison to the social planner. Content innovation strengthens the contribution of the eyeball's side to the network value for advertisers. Furthermore, advertising innovation not only mitigates the nuisance cost for eyeballs but also encourages the media monopolist to impose more substantial pricing "*penalties*" on advertisers for this nuisance, compared to the social planner.

Corollary 2 establishes the condition under which the monopolist devotes the largest R&D efforts to one side.

Corollary 2. Comparing the equilibrium R&D efforts to each other, we prove that:

$$\widehat{x}^B > (\leq)\widehat{x}^S \text{ if } \psi > (\leq)\, 1 \text{ or } \omega^B > (\leq)\omega^S$$

Proof. See Appendix. ∎

According to Corollary 2, to ensure a profitable return on investment in R&D, the media platform prioritizes investing the most in R&D on the side of the market with the strongest reference, where customers are most willing to pay for the pre-innovation media offering. Therefore, before initiating an R&D project on either side, the media platform must conduct a thorough market potential analysis to identify the side with the strongest reference and the highest potential for profitability. Furthermore, Corollary 2 shows that countervailing cross-externalities do not influence the media platform's decision to invest the most in R&D on one side. This indicates that the media monopolist recognizes the importance of the *inherent* value of its platform for each customer group and how it shapes the magnitude of the cross-externalities.

The result stated in Corollary 2 may also be linked to the fact that the media monopoly invests more in the strongest basic market to avoid its *excessive inertia* (Farrell & Saloner, 1985). This means that earlier (loyal) consumers in this market may be very stuck with the older version of the media offering and have difficulty diverting to the upgraded version. Increasing R&D investment can be an effective approach to persuade and assist these *locked-in* consumers in the media market to adopt new behaviors. Moreover, the media platform could allocate more resources to R&D to mitigate the higher switching costs incurred by consumers. To support this intuition, we read in *Twipe digital publishing* the following: "*A well-documented and powerful example is from the Arkansas Democrat Gazette which provided subscribers with tablets to read their digital replica ePaper. The experiment began as a way to return to profit after making a loss for the first time in 25 years in 2017. In March 2018, the move was trialed in the US town of Blytheville. Each Arkansas Democrat-Gazette subscriber was offered an iPad at their current print delivery rate ($34). Importantly, each subscriber was also offered a personal training session on how to use the tablet. Following the experiment, over 70% of the subscribers from Blytheville converted to digital*."[49]

Moreover, the media platform provides the lowest R&D efforts to the market that is least willing to pay for the pre-innovation version of the media offering, where *excessive momentum* is expected to prevail. For even slight modifications to the product, earlier consumers in this market will be encouraged to quickly switch to the new version.

In the following Proposition, we study the impact of θ^B on the equilibrium R&D efforts on side k, given $\delta < 1$. If the marginal ad nuisance rises, the platform will likely focus more on R&D efforts, especially in the B market, to help offset this effect. However, according to Proposition 5, this might not always be the case if the marginal benefit of the platform to advertisers outweighs the marginal cost of nuisance, that is, when $\theta^B < \theta^S$ or $\delta < 1$. In such situations, other factors may play a more significant role in determining the platform's optimal response to rising nuisance costs.

Proposition 5. Provided that $\delta < 1$, we show that (for $k = B, S$):

$$\frac{\partial \widehat{x}^k}{\partial \theta^B} < 0 \text{ for all } \theta^B \in \left]0, \theta^S\right[, \theta^S \in \left]0, 1\right[, \psi \in \left]0, +\infty\right[, \text{and } \gamma \in \left]\gamma_2, +\infty\right[$$

Proof. See Appendix A. ■

If the marginal ad nuisance increases, the media monopoly has less incentive to undertake R&D efforts on both sides. We give the following intuitions:

- $\frac{\partial \widehat{x}^B}{\partial \theta^B} < 0$: Increasing the quality of media content on side B (by rising $\widehat{x}^B$) can attract more eyeballs to the media platform. Furthermore, due to positive cross-externalities, more advertisers are likely to join the platform, especially since $\theta^S > \theta^B$ or $\delta < 1$. Therefore, this improvement can also have an adverse effect, increasing annoying ads that can offset the positive impact of the content upgrade and lead to a decrease in demand on side B. As a consequence, investing in R&D on side B may not yield a sufficient return on investment, as Proposition 4 shows. To address this challenge, the platform may opt to decrease its R&D efforts on side B when θ^B is expected to increase, to achieve a balance between *content quality* and *ad nuisance*.
- $\frac{\partial \widehat{x}^S}{\partial \theta^B} < 0$: The media platform anticipates that increased R&D efforts on the S side will significantly enhance the quality of advertisements, making advertisers more willing to pay for advertising, thus increasing their demand for the platform. However, if the advertising becomes too intrusive, it may lead to a decline in demand from eyeballs. The positive cross-externalities from side B to side S may also lead to a decrease in demand from advertisers. To recover R&D costs, the media monopolist may reduce its R&D efforts on the S side when it expects an increase in advertising nuisance. In summary, the media platform aims to improve the quality of advertisements through increased R&D efforts on the S side. However, if advertising becomes too intrusive, it may negatively impact the platform's demand from both advertisers and the audience. The media monopolist may adjust its R&D efforts to balance the cost recovery and demand from both sides.

It is worth noting that when advertising is relatively low (i.e., $\delta < 1$), the media monopoly may face a dilemma in investing in R&D due to advertisers' emphasis on increasing eyeball engagement. However, as the level of advertising annoyance increases, the monopolist recognizes that advertisers, who contribute to this annoyance, are not solely attracted by the high-quality advertising service but also by the media content that appeals to a broader audience. Therefore, the monopolist tends to balance the demands of advertisers and eyeballs when deciding where to focus its R&D efforts. We also highlight the importance of considering the countervailing interactions of advertisers and eyeballs in shaping the R&D efforts when the ad nuisance is relatively low.

5.2 | Reversed D&C pricing strategy: on the role of the equilibrium R&D efforts

To validate the economic insights outlined in the analysis of Proposition 3 above, we explore in Proposition 6 how the platform's equilibrium pricing strategy is influenced by the equilibrium R&D efforts.

Proposition 6. Given $\delta < 1$, we show the following:

Result i The media monopolist plans to serve the eyeballs for free or at a below-cost price, that is,

$$\widehat{p}^B \leq 0 \text{ and } \widehat{p}^S > 0 \text{ if } \widehat{x}^B \leq \widetilde{\widehat{x}}^B$$

with

$$\widetilde{\widehat{x}}^B = \theta^S \widehat{x}^S < \widehat{x}^S$$

Result ii The media monopolist plans to reverse the D&C pricing strategy, that is,

$$\widehat{p}^k > 0 \text{ and } \widehat{p}^B \geq \widehat{p}^S \text{ if } \widehat{x}^B \geq \smile\widehat{x}^B$$

with

$$\smile\widehat{x}^B = \left(\frac{1+\theta^S}{1-\theta^B}\right)\widehat{x}^S > \widehat{x}^S$$

Proof. See Appendix A. ■

The results presented in Proposition 6 confirm the intuitions brought to the analysis of the pricing equilibrium for given R&D efforts (see the analysis of Proposition 3 above).[50]

Result (i)

The platform will adopt the *freeness pricing strategy* if the equilibrium R&D efforts on side B remain relatively low and fall below the threshold $\widetilde{\widehat{x}}^B$. Below this *freeness R&D threshold*, the media monopoly will find it optimal to price eyeballs at or below the marginal cost. This R&D threshold conveys a message to the monopolist that the R&D program on the eyeball side will not be *efficient* enough to *produce* the necessary content quality level to attract eyeballs. To offset the relatively lower R&D efforts, indicative of a subsequent decline in content quality, the monopolist might opt to provide the content for eyeballs at no cost or even subsidize it.

Result (ii)

The media platform intends to reverse the D&C pricing strategy when it achieves relatively greater equilibrium R&D efforts in the eyeball market. The monopolist recognizes that it is the high quality of the media content that will persuade eyeballs to pay a higher price, despite the advertising nuisance they may encounter. As previously mentioned, some newspapers are no longer free of charge in the digital realm, considered an innovation. A Reuters study suggests that "*publishers need to focus on their key strengths, with 53% of subscribers to online news brands saying their top reason for paying for news is better quality than they can find from free source*." In the "*What's New in Publishing*" web portal, *Erik Martin* reports that *Matt Skibinski* states that "*in order to get your readers to pay for your digital content, you have to actually ask them to pay. In the past, many publishers were too conservative with their meter rules, and as a result, they would only ever 'stop' a small percentage of readers with a subscription ask. We're now seeing publishers become more confident in saying to readers, we have content that is high quality, valuable, and worth paying for*."[51]

We *shall* define $\smile\widehat{x}^B$ as the critical threshold of R&D efforts in market *B*. This threshold serves as a proxy for innovation and triggers a reversal of the D&C pricing strategy by the media platform. The main findings of Proposition 6 are summarized in Figure S5, which can be found in Appendix A.

5.3 | The see-saw R&D rule

Although analyzing the assumption that the relative advertising nuisance is high (i.e., $\delta \geq 1$) may complicate the clarity and exposition of our paper, we are intrigued by a very interesting result. Accordingly, in Corollary 3, we define what we *shall* call the R&D *seesaw rule* (Anderson & Peitz, 2020; Rochet & Tirole, 2003): *an increase in the marginal advertising nuisance increases the R&D efforts undertaken on one side and decreases those undertaken on the opposite side*. This rule is not applicable when the relative advertising nuisance is low.

Corollary 3. Given $\delta \geq 1$, the *R&D see-saw rule* holds on each side. We have:

$$\frac{\partial \widehat{x}^B}{\partial \theta^B} \geq 0 \text{ and } \frac{\partial \widehat{x}^S}{\partial \theta^B} < 0 \text{ under } \Omega_8$$

and

$$\frac{\partial \widehat{x}^B}{\partial \theta^B} < 0 \text{ and } \frac{\partial \widehat{x}^S}{\partial \theta^B} \geq 0 \text{ under } \Omega_9$$

The conditions Ω_8 and Ω_9 are stated in Appendix B.

Proof. See Appendix B. ■

Given that the *relative marginal advertising nuisance is high*, that is, $\delta \geq 1$, we interestingly note the following intuitions:

- $\frac{\partial \widehat{x}^B}{\partial \theta^B} \geq 0$ and $\frac{\partial \widehat{x}^S}{\partial \theta^B} < 0$: When there is a marginal increase in θ^B, the media platform adapts by augmenting the equilibrium R&D efforts on the *B*-side while diminishing those on the *S*-side. This response is driven by the platform's commitment to enhancing content quality, thereby mitigating the pronounced advertising nuisance on the *B*-market. This is reinforced by reducing the advertising quality designated for advertisers. Consequently, in the presence of exacerbated advertising nuisance (given $\delta \geq 1$), the platform endeavors to capture the attention of eyeballs by improving the quality of the media content offered to them, concomitantly reducing the quality of the advertising provided to advertisers. To illustrate this relationship, Figure S6 in Appendix B depicts the variation of $\widehat{x}^B$ w. r. t $\left(\theta^B\right)$ under Ω_8.
- $\frac{\partial \widehat{x}^B}{\partial \theta^B} < 0$ and $\frac{\partial \widehat{x}^S}{\partial \theta^B} \geq 0$: In response to an increase in marginal advertising nuisance, the media platform adjusts by decreasing R&D efforts on the *B*-side while increasing those on the *S*-side. This adjustment is driven by the relatively low pre-innovation market potential of market *B* under Ω_9, posing challenges in generating a sufficient return on investment in R&D. Additionally, the limited attractiveness of the *B*-side for the *S*-side, along with heightened competition among advertisers, intensifies rivalry. As a result, the platform strategically aims to attract advertisers by providing them with an appealing quality of advertising service, particularly considering the higher aversion of eyeballs to ads. Moreover, the platform aims to alleviate advertising nuisance for eyeballs by exposing them to enticing advertisements. Figure S7 in Appendix B illustrates the relationship between $\widehat{x}^S$ and θ^B under Ω_9.

5.4 | Solving the *chicken-and-egg* problem: practical insights for media platforms

Our paper thoroughly explores the pivotal role of innovation in addressing *the chicken-and-egg* problem encountered by media platforms. We emphasize that innovation acts as a catalyst, attracting users from both sides to join the platform and opt for premium services. Moreover, it plays a crucial role in alleviating ad nuisance for eyeballs, prompting the media platform to strategically reconsider traditional pricing strategies.

Our approach to innovation encompasses a focus on demand-driving strategies, including engaging ad formats and advancements in data analytics and targeting capabilities. These innovations aim to strike a delicate balance, making ads more appealing to advertisers while ensuring that eyeballs perceive them as less intrusive. Simultaneously, we recognize that content quality and diversity are paramount factors for attracting and retaining eyeballs, indirectly benefiting advertisers by fostering a larger and more engaged audience.

The media platform can effectively address the *chicken-and-egg* problem from two primary, yet not mutually exclusive, perspectives:

- Innovating on the eyeball's side
  Innovating on the eyeball's side attracts a larger audience to the media platform, encouraging substantial advertisers to participate due to the positive indirect externalities generated by eyeballs. However, this can result in additional nuisance for the eyeballs. To counteract this, advertising innovation becomes crucial, helping the platform alleviate the resulting nuisance and ensuring the harmonious coexistence of both sides.
- Innovating on the advertiser's side
  Innovation on the advertiser's side generates increased demand for advertising through the media platform. Consequently, there is reduced participation from eyeballs due to the negative indirect externalities imposed by advertisers. In response to this dynamic, innovation in media content becomes essential. This innovation enables the platform to alleviate the resulting nuisance and maintain a balanced presence for both customer groups.

Additionally, technological progress, involving virtual and augmented reality technologies and artificial intelligence for content recommendation and targeting, enhances advertising experiences on platforms. This boosts appeal to advertisers. The overall strategy includes innovative advertising models (like native and interactive formats), transparency and privacy measures, collaboration with stakeholders, and dynamic pricing based on user engagement metrics. Together, these elements form a robust framework for media platforms to navigate the complexities of the *chicken-and-egg* problem. This approach aims to create a more sustainable media ecosystem, benefiting both advertisers and eyeballs.

6 | POLICY IMPLICATIONS

Our paper has several policy implications that are worth noting. Specifically, the following recommendations can be drawn from our findings:

- *Assessing market power and innovation*: Policymakers should carefully assess the platform's market power and potential distortions resulting from its pricing strategy, taking into account how the platform manages its pricing policy on each side and how countervailing indirect network externalities impact this strategy. Additionally, policymakers should consider the level of innovation brought to one side of the platform, as well as advertising nuisance thresholds that guide the platform in adopting a freeness pricing strategy for eyeballs and potentially reversing the standard D&C pricing strategy.
- *Promoting competition in low advertising reach markets*: Policymakers should pay close attention to the advertising reach of media monopoly platforms when considering policies related to pricing and competition. Specifically, regulators should consider implementing measures to promote competition in markets with low advertising reach, such as preventing monopolies from using below-cost pricing to drive out competitors. In markets with high advertising reach, regulators may need to consider measures to prevent monopolies from charging excessive prices to eyeballs or exploiting their market power to the detriment of advertisers.
- *Encouraging balanced R&D efforts*: Policymakers should incentivize any media platform to invest in high-quality R&D efforts on both sides while being aware of its potential for deliberate underinvestment to reduce demand and increase prices. Policymakers should also investigate whether the R&D see-saw rule is a *predatory* R&D behavior of the monopoly platform.
- *Establishing an R&D threshold*: To measure the level of innovation and therefore the media good quality, policymakers should collaborate with industry experts and stakeholders to establish an R&D threshold. This threshold can serve as a benchmark and be adjusted over time to reflect changing market conditions.
- *Balancing content quality and advertising nuisance*: Policymakers must carefully consider the potential trade-offs between content quality and advertising nuisance within the eyeball market. Should content quality successfully alleviate the impact of advertising nuisance, granting the platform the leeway to set a higher access price for eyeballs relative to advertisers could foster the establishment of sustainable revenue streams. Nevertheless, in instances where the advertising nuisance becomes overly substantial, policymakers may need to delve into regulatory measures. Such measures could encompass restrictions on advertising volume on the platform or the implementation of safeguards to prevent excessive disruption to the eyeball experience.

In their overarching strategy, policymakers must aim for equilibrium in the platform's pricing and R&D initiatives on both sides, considering aspects such as market power, scale distortions, countervailing indirect network externalities, and the extent of advertising nuisance. A meticulous examination of these factors enables policymakers to guarantee fair and efficient platform operations, ensuring that eyeballs not only relish high-quality content but also encounter less intrusive, high-quality advertising.

7 | CONCLUSION

In this paper, we investigate the incentives of a monopolistic media platform to engage in demand-driving innovation when eyeballs and advertisers interact in countervailing ways. We also aim to analyze the role of innovation in resolving the *chicken-and-egg* dilemma and how it may influence the platform's pricing strategy. To do this, we allow the media monopoly to solve a two-stage optimization program. In the first stage, it determines the optimal R&D efforts. In the second stage, it chooses the optimal pricing policy on both sides taking into account the R&D efforts.

Our investigation yields several insightful findings, significantly *expanding upon the existing literature on two-sided markets*. In the pricing stage, we establish optimal pricing rules, introducing an additional externality-internalization term alongside conventional marginal cost and market power elements. A comparative analysis between the monopoly's optimal pricing rule and that of a social planner brings to light two noteworthy sources of market distortion: market power and scale distortions. Notably, *positive* scale distortion emerges on the eyeballs' side, while *negative* distortion manifests on the advertiser's side in the presence of countervailing interactions. Exploring the impact of marginal advertising nuisance on optimal prices uncovers *new and counterintuitive revelations*. Under specific conditions, an increase in marginal advertising nuisance results in *unexpected* price variations, leading to an increase (decrease) in the charges levied on eyeballs (advertisers). These findings intricately intertwine with the scale of innovation on each side. Furthermore, under certain conditions, we observe a *reversal* of the D&C pricing strategy. Notably, this occurs even when eyeballs suffer from the negative impact of increased advertiser participation. This highlights the media platform's approach to designing pricing policies, showcasing its sensitivity not only to the magnitude of indirect network externalities but also to the scale of innovation provided to each side.

Transitioning to the R&D stage, we establish an *equilibrium rule* for R&D on each side, ensuring *cost recovery* at the margin. Our study reveals that the platform allocates the highest R&D expenditures to the side with the strongest reference market, carefully considering the *excess inertia* effect. In scenarios with low relative advertising nuisance, equilibrium R&D efforts on both sides decrease in response to rising marginal ad nuisance. This approach stems from the platform's awareness that advertisers, the source of ad nuisance, are enticed not only by the quality of ads intended for them but also by the quality of the content offered to eyeballs. Moreover, we establish that, during R&D efforts, the media platform *plans to reverse the D&C pricing strategy* when engaging in the greatest equilibrium R&D efforts in the eyeball market. This emphasizes the media monopolist's awareness that the strong attractiveness of resulting media content quality induces eyeballs to pay a higher price despite the ad nuisance they endure. We introduce an *innovation proxy* indicating the *content quality attractiveness* required to reverse the D&C pricing strategy, thus solving the *chicken-and-egg* problem. In instances of high relative advertising nuisance, we define the R&D seesaw rule, showcasing that an increase in ad marginal nuisance empowers the media platform to increase (diminish) the R&D efforts on the eyeball (advertiser) side. This highlights the platform's tendency, in the presence of exacerbated advertising nuisance, to attract more eyeballs not only by boosting the quality of the content but also by limiting the quality of the ads.

Our paper can be extended in several directions for future research. First, models can be developed by studying the incentives for innovation of competing media platforms when advertising nuisance is significant. Second, it would be interesting to examine the effectiveness of media innovation projects when environmental and social concerns predominate. In this context, it is possible to answer the following questions: (i) what if intense media product innovation results in greater use of scarce resources? (ii) What if populism and fake news were prevalent due to the eye-catching appeal of media innovation? And (iii) how does media innovation meet the CSR objectives of local authorities? Finally, it would also be important to estimate econometrically to what extent media innovation intensifies/reduces advertising nuisance.

CONFLICT OF INTEREST STATEMENT

The authors of this paper declare that there are no conflicts of interest regarding the publication of this article. This includes, but is not limited to, financial, personal, or professional affiliations that could potentially influence or bias the work presented in this paper.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

ORCID

Chokri Aloui https://orcid.org/0000-0002-4048-7197

ENDNOTES

[1] We are grateful to an anonymous referee for insightful comments and helpful suggestions, which led to significant improvements in the paper. Any remaining errors are, of course, ours.

[2] Throughout this paper, eyeballs represent all media customers other than advertisers, such as readers, viewers, listeners, and Internet users.

[3] For a definition of ad avoidance and the three means by which eyeballs avoid ads (cognitive, behavioral, and mechanical), see Speck and Elliott (1997).

[4] On ad blocking, see Miroglio et al. (2018), Shiller et al. (2018), and Suárez and García-Mariñoso (2021), among others.

[5] For details, see https://www.techadvisor.com/article/1371233/netflix-basic-with-ads-not-worth-price.html.

[6] Further details are in https://www.digitaltrends.com/home-theater/what-is-youtube-premium/.

[7] For details, see https://fourweekmba.com/the-new-york-times-business-model/.

[8] Hagiu and Hałaburda (2014) define three network expectation modalities according to the information held by one side on the price practiced on the opposite side. These authors emphasize that a side forms responsive (resp. passive) expectations when it is informed (uninformed) of the price paid by the other group. Further, they examine wary expectations which refer to the fact that each side can build expectations based on the price it pays.

[9] Anderson and Gabszewicz (2006), page 579, claim that "*the platform recognizes the trade-off between higher ad levels that lead to more revenue per viewer, and the loss in viewer base from ramping up ad levels too high*."

[10] Many media platforms, including YouTube and Facebook, independently create and broadcast ads, eliminating the reliance on external advertising agencies. Traditional channels like CNN, BBC, and NPR also

produce and air advertisements directly, showcasing a trend toward in-house ad creation and broadcasting.

11 On media convergence, see Jenkins (2006).

12 We cite, among others, Rochet and Tirole (2003); Evans (2003); Jullien et al. (2021); Jullien and Sand-Zantman (2021); and Weng and Luo (2023).

13 Belleflamme and Peitz (2021) note on page 117: "… *to avoid the null equilibrium, the platform applies a divide-and-conquer strategy, setting a low (possibly negative) fee for one group (divide) and making it up by setting a high fee for the other group (conquer)*."

14 For more details on this literature, readers can refer to Anderson and Gabszewicz (2006) and Anderson and Jullien (2015), among others.

15 To the best of our knowledge, the empirical frameworks that have dealt with innovation in a two-sided market are Boudreau (2012) and Zhang and Tang (2019).

16 While other prior studies have explored topics such as the strategic utilization of first-party content (Hagiu & Spulber, 2013), the trade-off between investing in high platform performance and facilitating third-party content development (Anderson et al., 2014), the impact of cooperation on R&D efforts in a duopoly platform (Bourreau & Verdier, 2014), the innovation's impact on the pricing policy of telecommunications operators (Calabrese et al., 2008), and the presence of non-innovative competing platforms on seller incentives (Belleflamme & Peitz, 2010), our specific focus on two-sided R&D investment, coupled with the consideration of countervailing interactions, offers a distinctive perspective that enhances our understanding of the multifaceted nature of two-sided markets.

17 BeIN Sports operates as a dominant player, if not a local monopoly, in the realm of sporting event broadcasting. It holds exclusive rights to broadcast major sports events, thereby enjoying a significant market advantage. Netflix, on the other hand, has established a stronghold in the media streaming industry, effectively.

18 The media platform is assumed to have sufficient capacity to meet potential demands from both sides.

19 In our paper, the utility on side k associated with not joining the media platform (the outside option) is normalized to zero.

20 Note that a marginal increase in N^S (resp.N^B) reduces (resp. increases) the net utility of media good B (resp. S) by θ^B (resp. θ^S) since $\frac{\partial U^B}{\partial N^S} = -\theta^B < 0$ (resp. $\frac{\partial U^S}{\partial N^B} = \theta^S > 0$).

21 For the sake of simplicity, we do not *explicitly* model within-side network externalities, for example, the overuse of a limited-capacity bandwidth that degrades the quality of movies for viewers and/or the competition between advertisers to attract eyeballs' attention.

22 We bring these parameters closer to practice. θ^B can be the annoying emotion that a football fan experiences when a commercial cuts a match for the football team she supports. It can also be the willingness to pay of an eyeball to escape an ad (See https://morningconsult.com/2017/09/23/consumers-love-hate-ads-wont-pay-escape/). θ^S can be the probability that an advertiser earns an additional dollar by *placing* an advertisement seen by an eyeball (a potential buyer). To keep the model parsimonious, we assume that all the eyeballs (advertisers) experience (procure) the same marginal network cost (marginal network benefit). Note further that, in our paper, eyeballs dislike ads and not the advertised brands.

23 Exceptionally, we relax this assumption in Corollary 3 below where we define the *R&D see-saw rule* given $\delta \geq 1$.

24 In our paper, the trade between eyeballs and advertisers is kept *exogenous*.

25 To strengthen the justification for comparing prices of both sides, we can easily interpret the payment made, whether by the eyeballs or the advertisers, as an "*access price*." It's important to note that we are not considering situations where a media monopoly imposes usage-based pricing on advertisers. For instance, we are disregarding the scenario where a newspaper sets a per-impression price for advertisers (Godes et al., 2009).

26 Tishler and Milstein (2009) also adopt this product innovation formalization.

27 The parameter $\omega^k > 0$ can be interpreted as the maximum the k-consumer is willing to pay for the legacy media platform. Thus, a^k reflects her maximum willingness to pay when the platform *also* goes digital. Additionally,ω^k can also indicate the platform's potential market among loyal or early customers on the k side.

28 It would be intriguing to consider how R&D investments on each side could impact the price sensitivity of that respective side. Furthermore, there is a possibility of positive spillover effects from R&D efforts in one market to the other. However, for the sake of simplicity, we have chosen to overlook these fascinating aspects. Incorporating these factors would introduce greater complexity to the model and the subsequent analyses.

29 Analytically, we can derive the same equilibrium arguments by simultaneously determining optimal prices and R&D efforts. Nevertheless, we opt for a sequential timeline (Knauff & Karbowski, 2021; Lambertini, 2003), which segregates price analysis from R&D analysis to closely mirror real-world scenarios. Our objective is to explore the impact of the pre-established R&D efforts on the membership pricing strategy of the media platform. It is important to highlight that the monopolist accurately discerns the network expectation modality on each side while undertaking the R&D projects.

30 Note that two factors can affect the *basic* maximum willingness to pay of side k: one in the *short term* (the expected network size of side l) and the other in the *long term* (the R&D efforts).

31 To learn more about this issue, please refer to the appendix of their paper.

32 Assuming responsive expectations, we follow the majority of the literature on two-sided markets. The study of the incentives of a media platform to innovate in the presence of *passive* or *wary* network expectations is beyond the scope of our paper and would be the subject of a future research.

33 Appendices A, B, and C can be found within the Supporting Information.

34 There should have been an additional term reflecting the marginal membership cost (which is normalized to zero in our paper). We can also interpret $p^k(x)$ as the equilibrium *profit margin* of the platform on the k side, given the R&D efforts.

35 For the sake of brevity and to focus only on the role of publicity nuisance, the analysis of the impact of the S-side network benefits on the equilibrium arguments (pricing and R&D) is not taken into account.

36 To simplify the exposition, all the conditions Ω_i, ($i = 1, ..., 17$) and the parameter thresholds θ_i^B ($i = 1,....,23$) and θ_i^S ($i = 1, ...,17$) are stated in the Appendices A, B, and C (see the Supporting Information). The subscripted numbers assigned to Ω_i and θ_i^k depend on the sequence of proofs.

37 Through a series of simplifications outlined in Appendix C, we affirm the continued validity of the interesting findings described in Proposition 2, even when accounting for the endogeneity of R&D efforts. To streamline our analysis and simplify the process, we focus on examining the impact of θ^B on prices under the assumption of exogenous R&D efforts. It is important to note that, as the equilibrium pricing rules in Proposition 1 remain valid, the same economic intuition continues to apply even when R&D efforts are endogenously determined.

38 It is a marginal-cost-based pricing on side B. Contrary to some papers on media industry (e.g., Ambrus et al., 2016; Anderson et al., 2012; Anderson & Coate, 2005; Athey et al., 2018; Gabszewicz et al., 2004)

which assume that the free access of eyeballs is a (*committed*) *exogenous* decision, we determine it *endogenously* to maintain the two-sidedness feature of the platform's pricing strategy.

[39] The subscript "*f*" denotes "*freeness pricing on side B*."

[40] In Appendix C, we validate the below-cost and the reversed divide-and-conquer pricing strategies, considering the endogeneity of the R&D efforts.

[41] Note that the price level (Rochet & Tirole, 2006) is $p(x) = p^B(x) + p^S(x) = (1 + \theta^B)q^B(x) + (1 - \theta^S)q^S(x) > 0$.

[42] For definitions of the advertising reach, see De Pelsmacker (2022). See also https://www.simulmedia.com/tv-advertising-glossary/what-is-reach-in-advertising.

[43] Comparing the two access prices is equivalent to comparing the *profit margins* as the marginal costs are normalized to zero.

[44] http://www.niemanlab.org/2012/05/the-newsonomics-of-majority-reader-revenue/.

[45] See https://www.theguardian.com/media/2003/jul/08/theguardian.pressandpublishing.

[46] See https://www.adweek.com/internationalsub/.

[47] Larry Kilman was the General Secretary of the World Association of Newspapers and News Publishers in 2015. See https://www.discoursemagazine.com/culture-and-society/2021/07/28/the-press-now-depends-on-readers-for-revenue-and-thats-a-big-problem-for-journalism/.

[48] All the R&D equilibrium arguments are stated in Appendix A.

[49] See https://www.twipemobile.com/encouraging-subscribers-to-move-from-print-to-digital/.

[50] As noted in footnote 40 above, through the simplifications detailed in Appendix C, we confirm the persistence of the outcomes outlined in Proposition 3, even when accounting for endogenous R&D efforts. Analyzing these results within the context of equilibrium R&D efforts allows us to unravel the importance of the magnitude of these efforts in counteracting the divide-and-conquer pricing strategy. The numerical simulations conducted in Appendix C further validate the relationships between the equilibrium R&D efforts on side *B* and the corresponding thresholds that delineate the strategies of freeness and non-discrimination pricing. Figures 8 to 13 in Appendix C serve to illustrate the main findings under endogenous R&D efforts.

[51] See https://whatsnewinpublishing.com/moving-readers-from-free-to-fee-an-inside-look-at-successful-premium-publishing-strategies/.

REFERENCES

Aloui, C., & Jebsi, K. (2022). Does corporate social responsibility solve the chicken-and-egg problem for a two-sided platform? *Managerial and Decision Economics*, *43*(7), 3235–3256. https://doi.org/10.1002/mde.3593

Ambrus, A., Calvano, E., & Reisinger, M. (2016). Either or both competition: A "two-sided" theory of advertising with overlapping viewerships. *American Economic Journal: Microeconomics*, *8*(3), 189–222. https://doi.org/10.1257/mic.20150019

Anderson, E. G. Jr., Parker, G. G., & Tan, B. (2014). Platform performance investment in the presence of network externalities. *Information Systems Research*, *25*(1), 152–172. https://doi.org/10.1287/isre.2013.0505

Anderson, S. P., & Coate, S. (2005). Market provision of broadcasting: A welfare analysis. *The Review of Economic Studies*, *72*(4), 947–972. https://doi.org/10.1111/0034-6527.00357

Anderson, S. P., Foros, Ø., Kind, H. J., & Peitz, M. (2012). Media market concentration, advertising levels, and ad prices. *International Journal of Industrial Organization*, *30*(3), 321–325. https://doi.org/10.1016/j.ijindorg.2011.11.003

Anderson, S. P., & Gabszewicz, J. J. (2006). The media and advertising: A tale of two-sided markets. *Handbook of the Economics of Art and Culture*, *1*, 567–614. https://doi.org/10.1016/S1574-0676(06)01018-0

Anderson, S. P., & Jullien, B. (2015). The advertising-financed business model in two-sided media markets. In *Handbook of media economics* (Vol. 1) (pp. 41–90). Elsevier. https://doi.org/10.1016/B978-0-444-62721-6.00002-0

Anderson, S. P., & Peitz, M. (2020). Media see-saws: Winners and losers in platform markets. *Journal of Economic Theory*, *186*, 104990. https://doi.org/10.1016/j.jet.2019.104990

Athey, S., Calvano, E., & Gans, J. S. (2018). The impact of consumer multi-homing on advertising markets and media competition. *Management Science*, *64*(4), 1574–1590. https://doi.org/10.1287/mnsc.2016.2675

Belleflamme, P., & Peitz, M. (2010). Platform competition and seller investment incentives. *European Economic Review*, *54*(8), 1059–1076. https://doi.org/10.1016/j.euroecorev.2010.03.001

Belleflamme, P., & Peitz, M. (2019). Price disclosure by two-sided platforms. *International Journal of Industrial Organization*, *67*, 102529. https://doi.org/10.1016/j.ijindorg.2019.102529

Belleflamme, P., & Peitz, M. (2021). *The economics of platforms*. Cambridge University Press. https://doi.org/10.1017/9781108696913

Boudreau, K. J. (2012). Let a thousand flowers bloom? An early look at large numbers of software app developers and patterns of innovation. *Organization Science*, *23*(5), 1409–1427. https://doi.org/10.1287/orsc.1110.0678

Bourreau, M., & Verdier, M. (2014). Cooperative and noncooperative R&D in two-sided markets. *Review of Network Economics*, *13*(2), 175–190. https://doi.org/10.1515/rne-2013-0123

Caillaud, B., & Jullien, B. (2003). Chicken & egg: Competition among intermediation service providers. *RAND Journal of Economics*, *34*, 309–328. https://doi.org/10.2307/1593720

Calabrese, A., Gastaldi, M., Iacovelli, I., & Ghiron, N. L. (2008). Innovation and competition in two-sided markets: The case of payment systems. *International Journal of Management and Network Economics*, *1*(1), 1–20. https://doi.org/10.1504/IJMNE.2008.018677

d'Aspremont, C., & Jacquemin, A. (1988). Cooperative and noncooperative R & D in duopoly with spillovers. *The American Economic Review*, *78*(5), 1133–1137.

De Pelsmacker, P. (2022). *Advanced introduction to advertising*. Edward Elgar Publishing.

Dou, G., He, P., & Xu, X. (2016). One-side value-added service investment and pricing strategies for a two-sided platform. *International Journal of Production Research*, *54*(13), 3808–3821. https://doi.org/10.1080/00207543.2016.1148275

Dou, G., Lin, X., & Xu, X. (2018). Value-added service investment strategy of a two-sided platform with the negative intra-group network externality. *Kybernetes*, *47*(5), 937–956. https://doi.org/10.1108/K-06-2017-0215

Elder, L., & Paul, R. (2020). *Fact over fake: A critical thinker's guide to media bias and political propaganda*. Foundation for Critical Thinking.

Evans, D. (2003). The antitrust economics of multi-sided platform markets. *In Yale Journal on Regulation*, 20, 325-384. https://openyls.law.yale.edu/bitstream/20.500.13051/8032/2/12_20YaleJonReg325_2003_.pdf

Farrell, J., & Saloner, G. (1985). Standardization, compatibility, and innovation. *The Rand Journal of Economics*, *16*, 70–83. https://doi.org/10.2307/2555589

Gabszewicz, J. J., Laussel, D., & Sonnac, N. (2001). Press advertising and the ascent of the 'Pensée Unique'. *European Economic Review*, *45*(4–6), 641–651. https://doi.org/10.1016/S0014-2921(01)00139-8

Gabszewicz, J. J., Laussel, D., & Sonnac, N. (2004). Programming and advertising competition in the broadcasting industry. *Journal of Economics & Management Strategy*, *13*(4), 657–669.

Godes, D., Ofek, E., & Sarvary, M. (2009). Content vs. advertising: The impact of competition on media firm strategy. *Marketing Science*, *28*(1), 20–35. https://doi.org/10.1287/mksc.1080.0390

Häckner, J. (2000). A note on price and quantity competition in differentiated oligopolies. *Journal of Economic Theory*, *93*(2), 233–239. https://doi.org/10.1006/jeth.2000.2654

Hagiu, A., & Hałaburda, H. (2014). Information and two-sided platform profits. *International Journal of Industrial Organization*, *34*, 25–35. https://doi.org/10.1016/j.ijindorg.2014.04.001

Hagiu, A., & Spulber, D. (2013). First-party content and coordination in two-sided markets. *Management Science*, *59*(4), 933–949. https://doi.org/10.1287/mnsc.1120.1577

Ivaldi, M., & Zhang, J. (2017). *Advertising competition in the free-to-air TV broadcasting industry*. CESifo Working Parers No. 6464, CES. https://www.cesifo.org/DocDL/cesifo1_wp6461.pdf

Jenkins, H. (2006). *Convergence culture: Where old and new media collide* (pp. 307–319). New York University Press.

Jullien, B., Pavan, A., & Rysman, M. (2021). Two-sided markets, pricing, and network effects. In *Handbook of industrial organization* (Vol. 4, Issue 1, pp. 485–592). Elsevier, https://doi.org/10.1016/bs.hesind.2021.11.007

Jullien, B., & Sand-Zantman, W. (2021). The economics of platforms: A theory guide for competition policy. *Information Economics and Policy*, *54*, 100880. https://doi.org/10.1016/j.infoecopol.2020.100880

Katz, M. L., & Shapiro, C. (1985). Network externalities, competition, and compatibility. *The American Economic Review*, *75*(3), 424–440.

Knauff, M., & Karbowski, A. (2021). R & D Investments in Markets with Network Effects. January, 225–250.

Lambertini, B. L. (2003). The monopolist's optimal R & D portfolio. *Oxford Economic Papers*, *55*, 561–578. https://doi.org/10.1093/oep/55.4.561

Li, H., Shen, Q., & Bart, Y. (2021). Dynamic resource allocation on multi-category two-sided platforms. *Management Science*, *67*(2), 984–1003. https://doi.org/10.1287/mnsc.2020.3586

Miroglio, B., Zeber, D., Kaye, J., & Weiss, R. (2018). The effect of ad blocking on user engagement with the web. *Proceedings of the 2018 World Wide Web Conference*, 813–821. https://doi.org/10.1145/3178876.3186162

Rochet, J., & Tirole, J. (2006). Two-sided markets: A progress report. *The Rand Journal of Economics*, *37*(3), 645–667. https://doi.org/10.1111/j.1756-2171.2006.tb00036.x

Rochet, J.-C., & Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association*, *1*(4), 990–1029. https://doi.org/10.1162/154247603322493212

Shiller, B., Waldfogel, J., & Ryan, J. (2018). The effect of ad blocking on website traffic and quality. *The Rand Journal of Economics*, *49*(1), 43–63. https://doi.org/10.1111/1756-2171.12218

Sonnac, N. (2000). Readers' attitudes toward press advertising: Are they ad-lovers or ad-averse? *The Journal of Media Economics*, *13*(4), 249–259. https://doi.org/10.1207/S15327736ME1304_4

Speck, P. S., & Elliott, M. T. (1997). Predictors of advertising avoidance in print and broadcast media. *Journal of Advertising*, *26*(3), 61–76. https://doi.org/10.1080/00913367.1997.10673529

Suárez, D., & García-Mariñoso, B. (2021). Does ad blocking have an effect on online shopping? *Telecommunications Policy*, *45*(3), 102089. https://doi.org/10.1016/j.telpol.2020.102089

Sui, R., Zhang, X., Dan, B., Zhang, H., & Liu, Y. (2023). Bilateral value-added service investment in platform competition with cross-side network effects under multihoming. *European Journal of Operational Research*, *304*(3), 952–963. https://doi.org/10.1016/j.ejor.2022.04.041

Tan, H., & Wright, J. (2021). Pricing distortions in multi-sided platforms. *International Journal of Industrial Organization*, *79*, 102732. https://doi.org/10.1016/j.ijindorg.2021.102732

Tishler, A., & Milstein, I. (2009). R&D wars and the effects of innovation on the success and survivability of firms in oligopoly markets. *International Journal of Industrial Organization*, *27*(4), 519–531. https://doi.org/10.1016/j.ijindorg.2008.12.004

Wei, W., Liu, W., Tang, O., Dong, C., & Liang, Y. (2023). CSR investment for a two-sided platform: Network externality and risk aversion. *European Journal of Operational Research*, *307*(2), 694–712. https://doi.org/10.1016/j.ejor.2022.08.048

Weng, Z., & Luo, P. (2023). Multi-sided? Operation mode of sharing economy enterprises. *Managerial and Decision Economics*, *44*(5), 2568–2581. https://doi.org/10.1002/mde.3833

Wilbur, K. C. (2008). A two-sided, empirical model of television advertising and viewing markets. *Marketing Science*, *27*(3), 356–378. https://doi.org/10.1287/mksc.1070.0303

Zhang, J. (2016). *The impact of advertising length caps on TV: Evidence from the French broadcast TV industry*, *Working Papers 16-06 NET Institute*. https://doi.org/10.2139/ssrn.2847856

Zhang, S., & Tang, T. (2019). Managing same-side and cross-side innovations in two-sided platforms. *Marketing Intelligence & Planning*, *37*(7), 770–790. https://doi.org/10.1108/MIP-03-2019-0156

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Aloui, C., & Jebsi, K. (2024). Demand-driving innovation, advertising nuisance, and a media platform optimal pricing. *Managerial and Decision Economics*, 1–18. https://doi.org/10.1002/mde.4188